



US009179055B2

(12) **United States Patent**  
**Hooton et al.**

(10) **Patent No.:** **US 9,179,055 B2**  
(45) **Date of Patent:** **Nov. 3, 2015**

(54) **CAMERA RELATED FEATURES OF A  
MOBILE PHONE OR COMPUTING DEVICE**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Lee E. Hooton**, Cupertino, CA (US);  
**Douglas S. Brodie**, Los Gatos, CA (US);  
**Matthew D. Hill**, Santa Clara, CA (US);  
**Nicholas G. Merz**, San Francisco, CA  
(US); **Scott A. Myers**, Saratoga, CA  
(US); **Terence N. Tam**, San Francisco,  
CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 14 days.

(21) Appl. No.: **14/255,893**

(22) Filed: **Apr. 17, 2014**

(65) **Prior Publication Data**

US 2015/0062419 A1 Mar. 5, 2015

**Related U.S. Application Data**

(60) Provisional application No. 61/873,745, filed on Sep.  
4, 2013.

(51) **Int. Cl.**  
**H04N 5/222** (2006.01)  
**H04N 5/225** (2006.01)  
**H04M 1/02** (2006.01)

(52) **U.S. Cl.**

CPC ..... **H04N 5/2254** (2013.01); **H04M 1/026**  
(2013.01); **H04M 1/0264** (2013.01); **H04N**  
**5/2251** (2013.01); **H04N 5/2252** (2013.01);  
**H04N 5/2257** (2013.01)

(58) **Field of Classification Search**

CPC . H04N 5/2254; H04N 5/2251; H04N 5/2257;  
H04N 5/2252; H04M 1/026; H04M 1/0264  
USPC ..... 348/373–375  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

2002/0075398 A1\* 6/2002 Milam et al. .... 348/374  
2008/0192124 A1\* 8/2008 Nagasaki ..... 348/208.11

\* cited by examiner

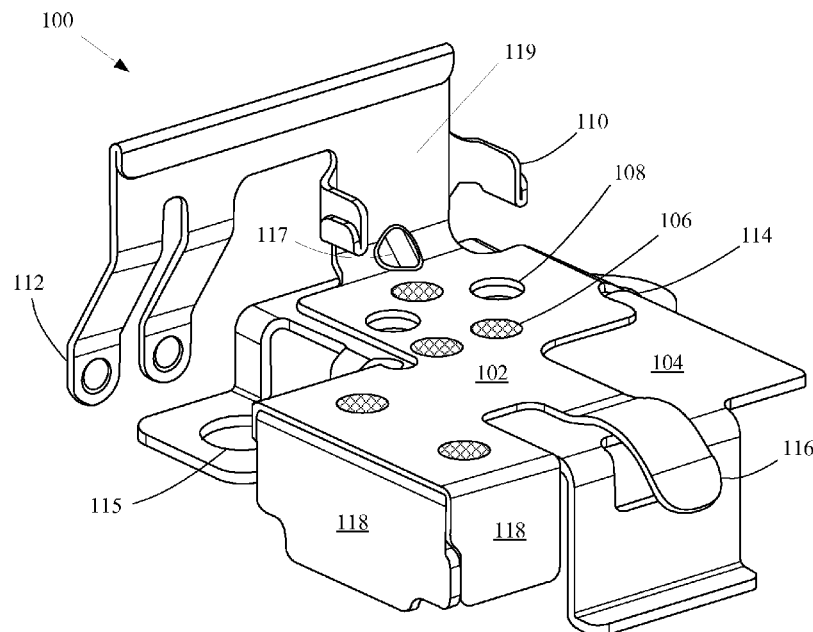
*Primary Examiner* — Yogesh Aggarwal

(74) *Attorney, Agent, or Firm* — Downey Brand LLP

(57) **ABSTRACT**

This application relates primarily to various apparatus and  
method for securing and protecting a camera module within a  
device housing. The securing and protecting elements are  
configured to take up minimal space within the device hous-  
ing so that available space for the camera module is maxi-  
mized. In some embodiments the securing elements can also  
include grounding features.

**20 Claims, 11 Drawing Sheets**



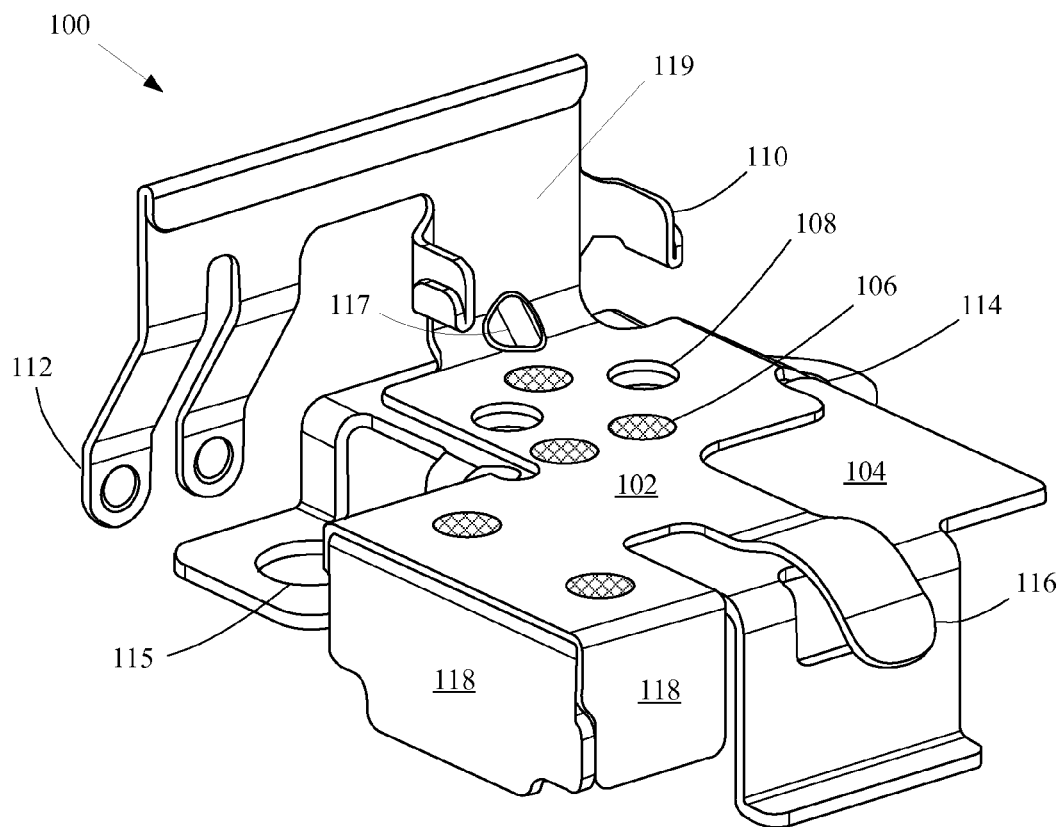


FIG. 1A

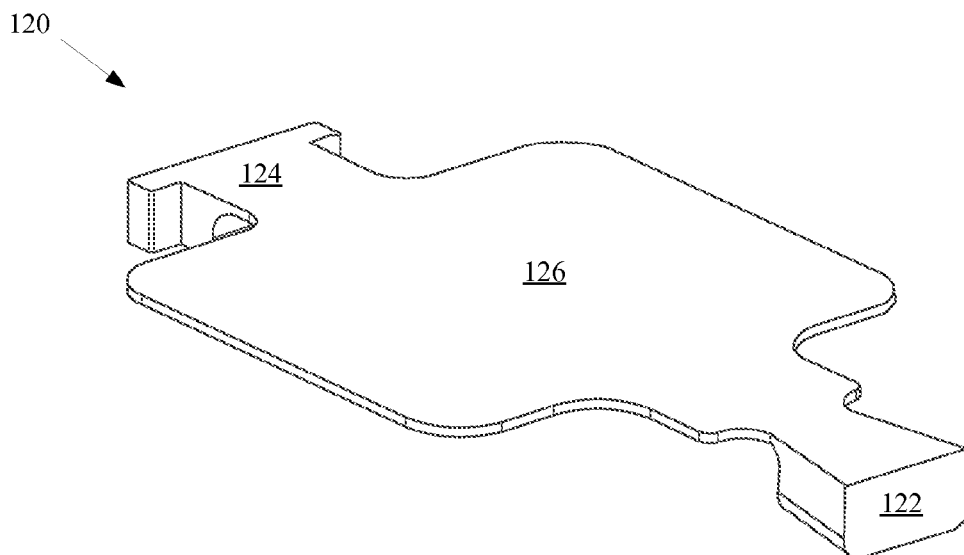
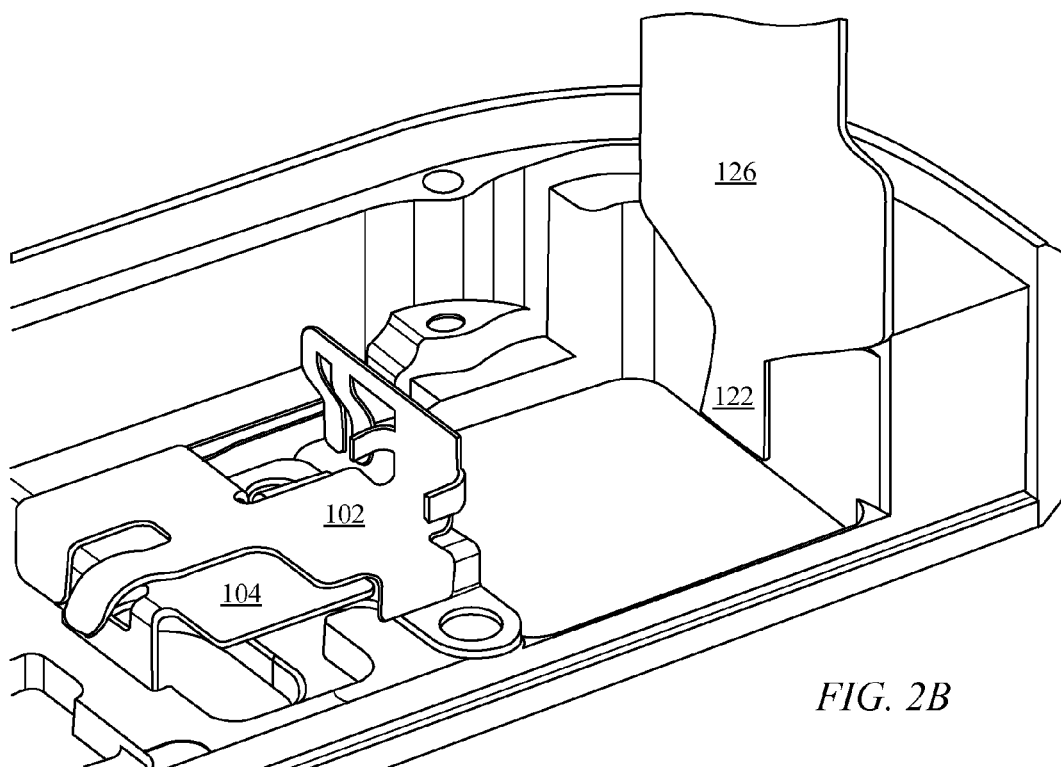
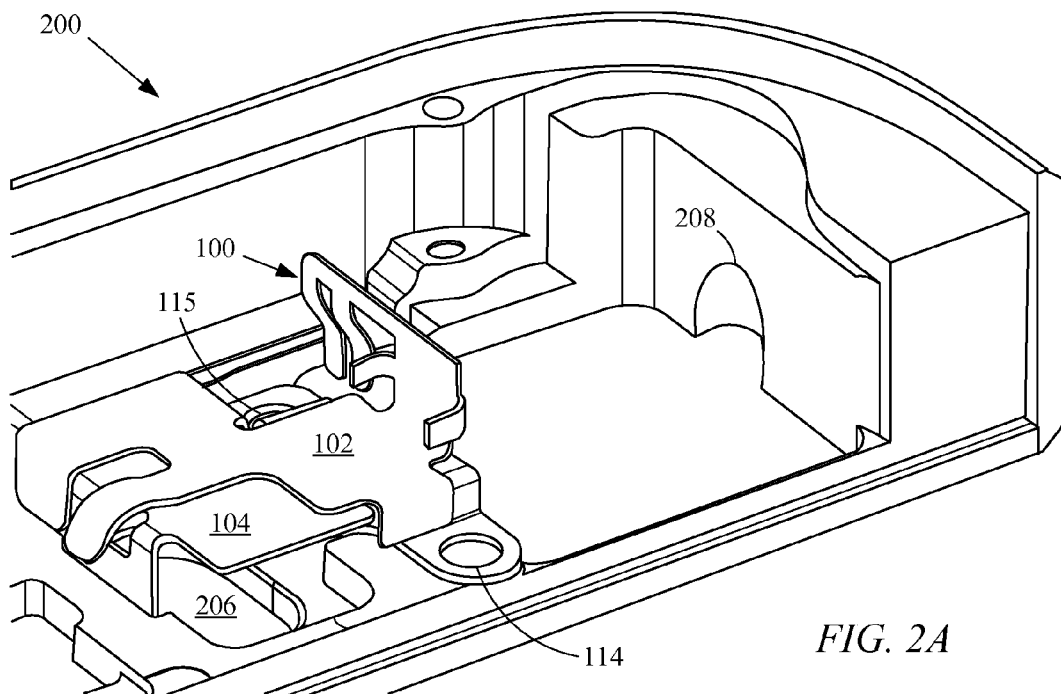


FIG. 1B



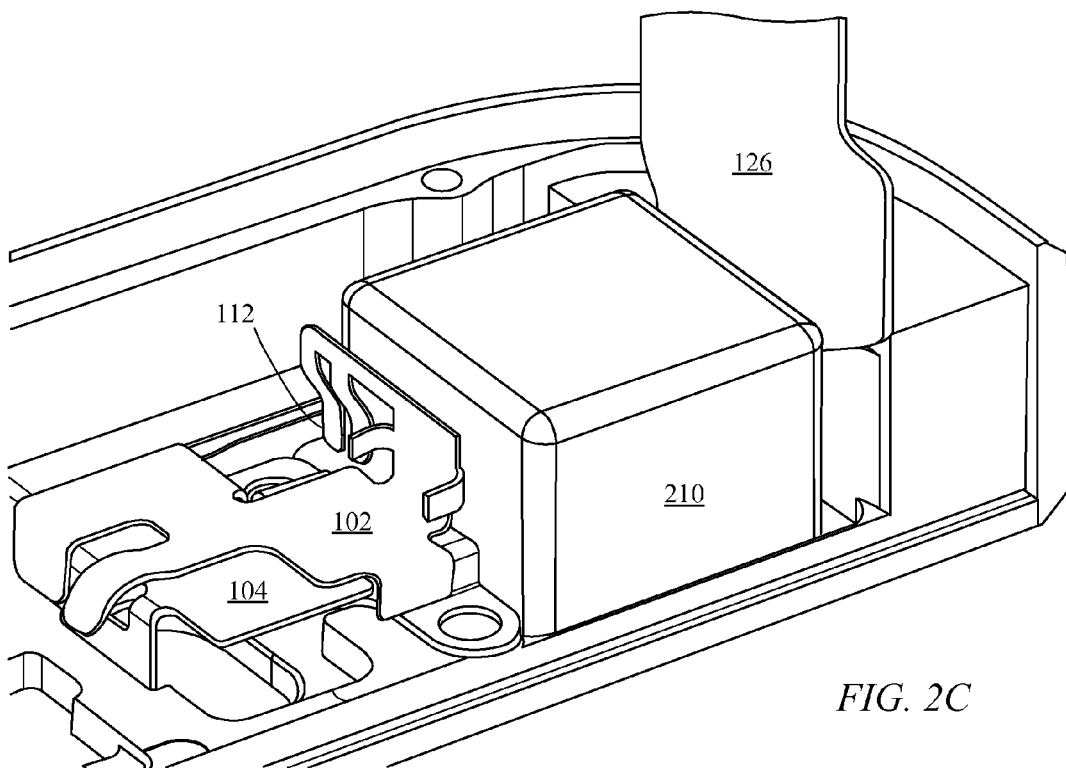


FIG. 2C

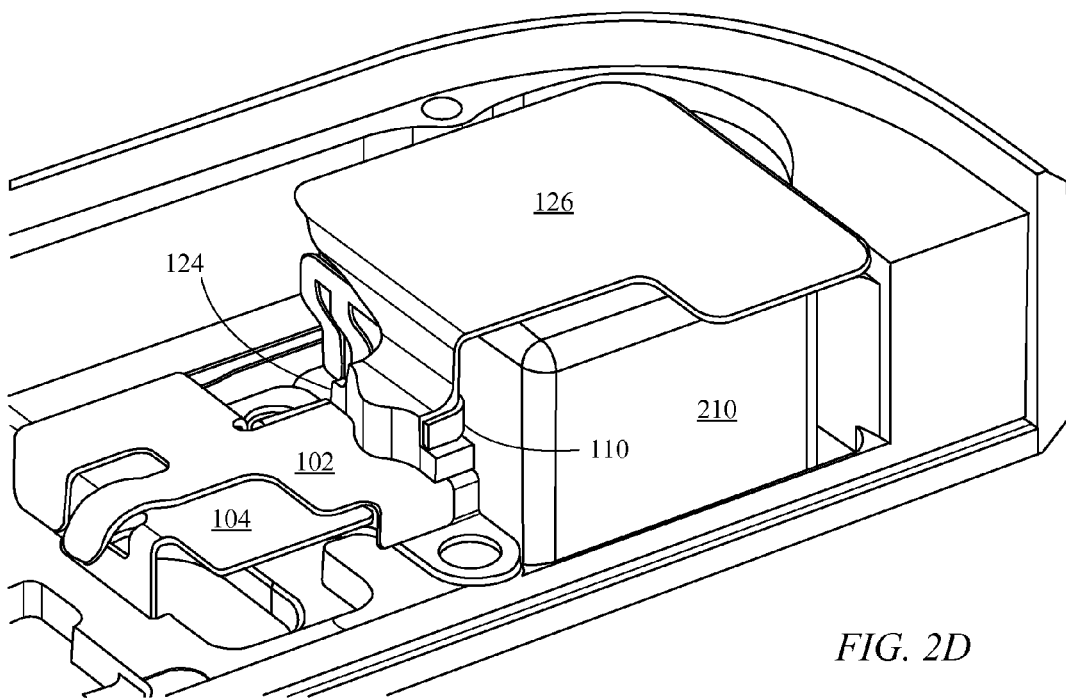


FIG. 2D

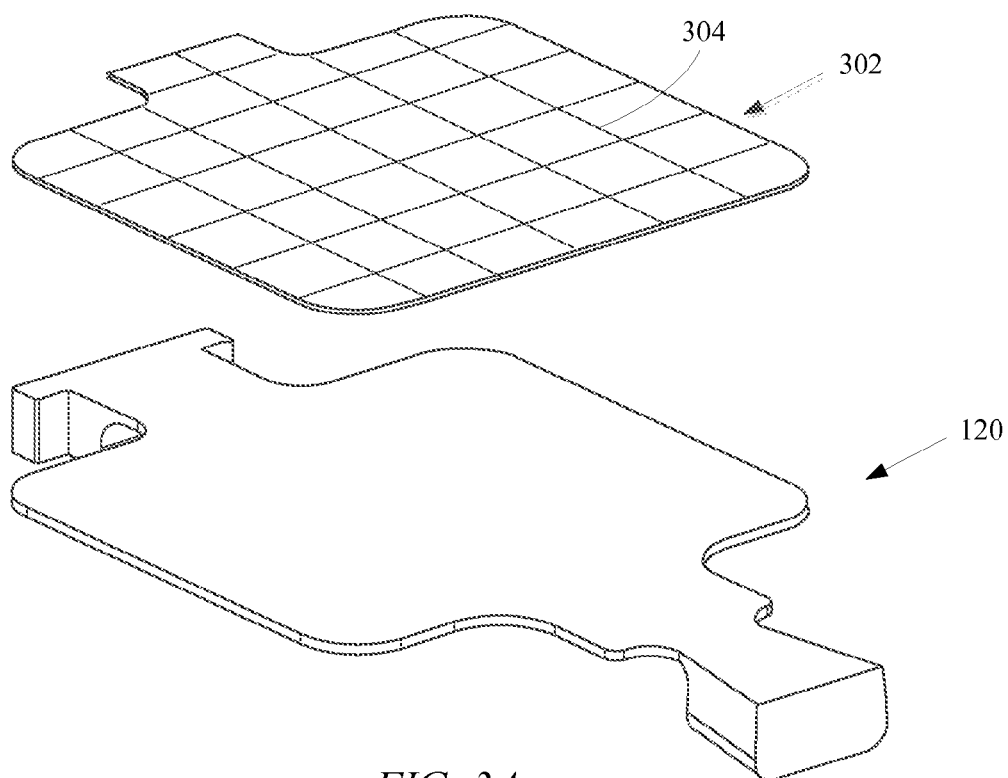


FIG. 3A

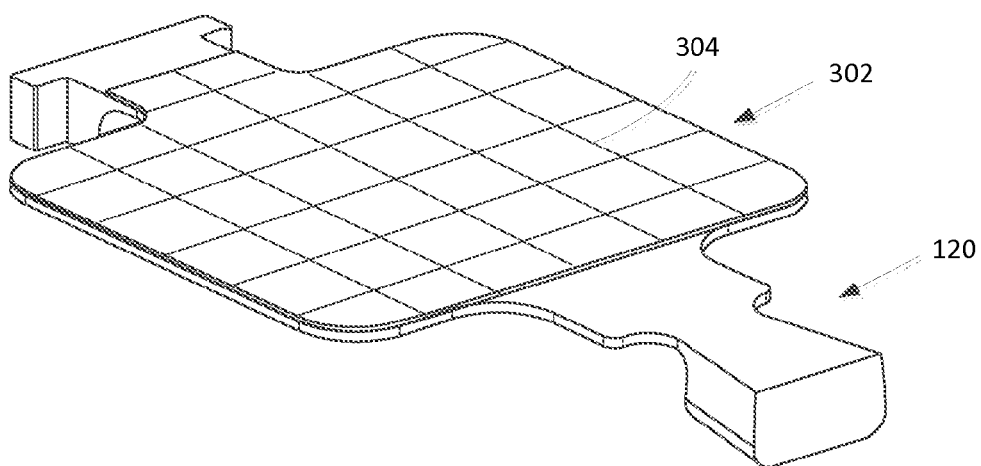


FIG. 3B

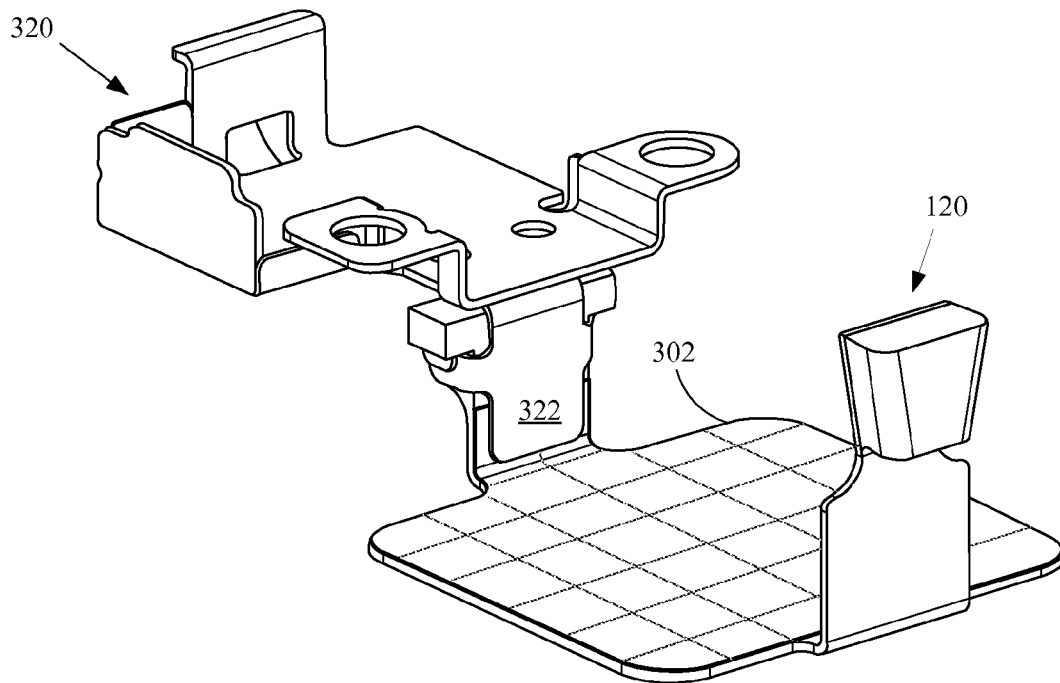


FIG. 3C

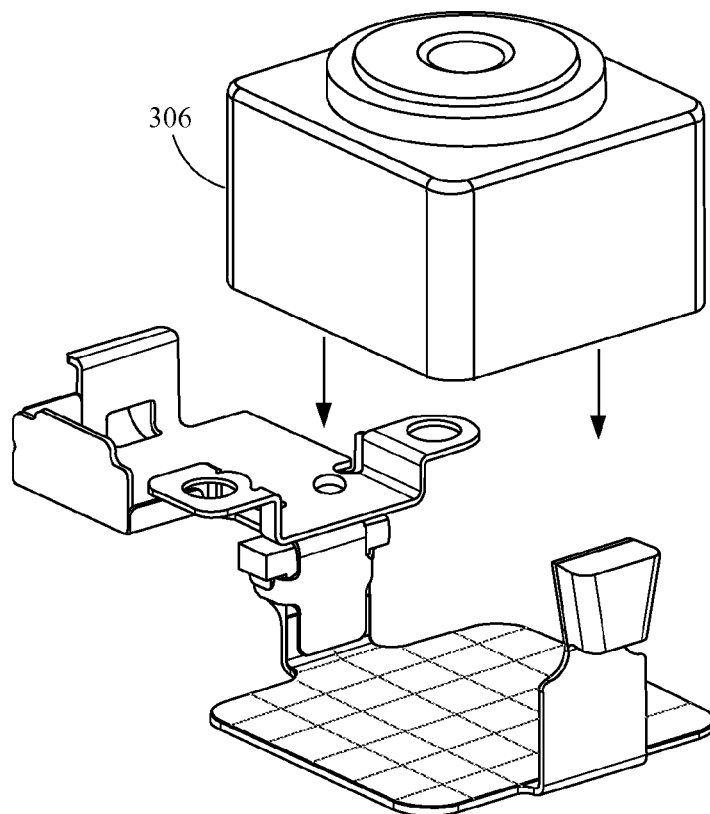


FIG. 3D

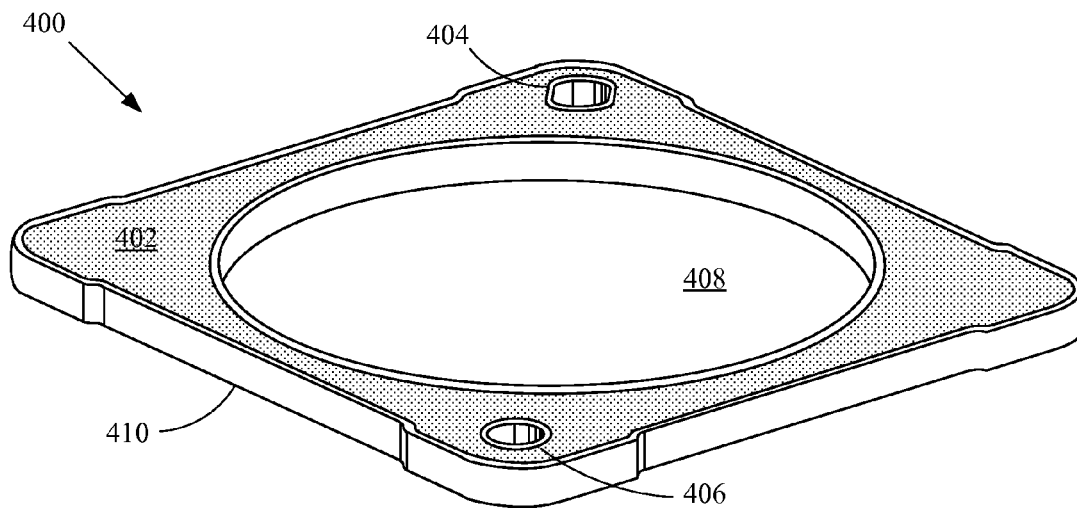


FIG. 4A

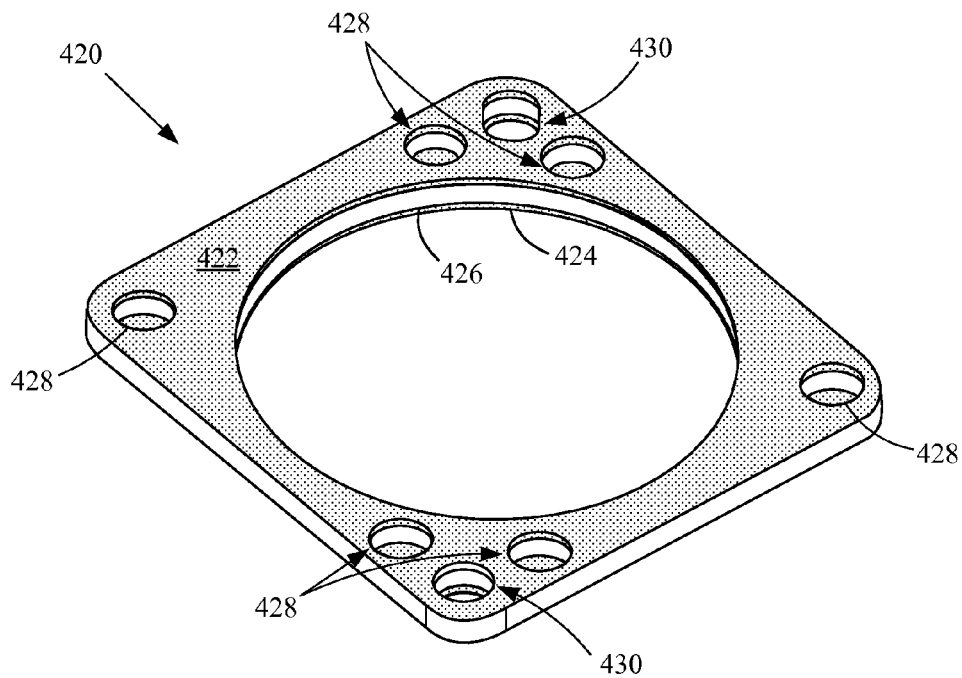


FIG. 4B

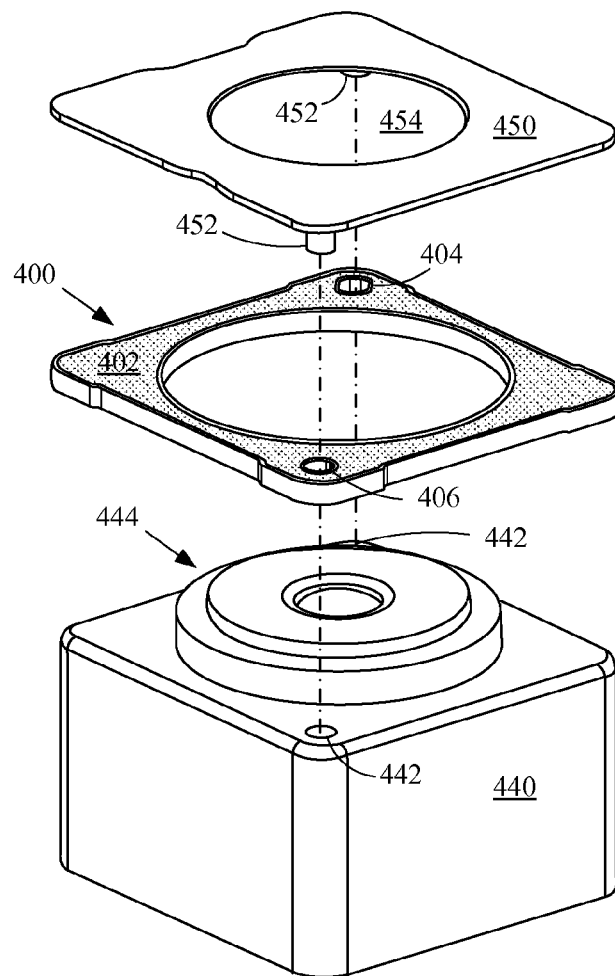


FIG. 4C

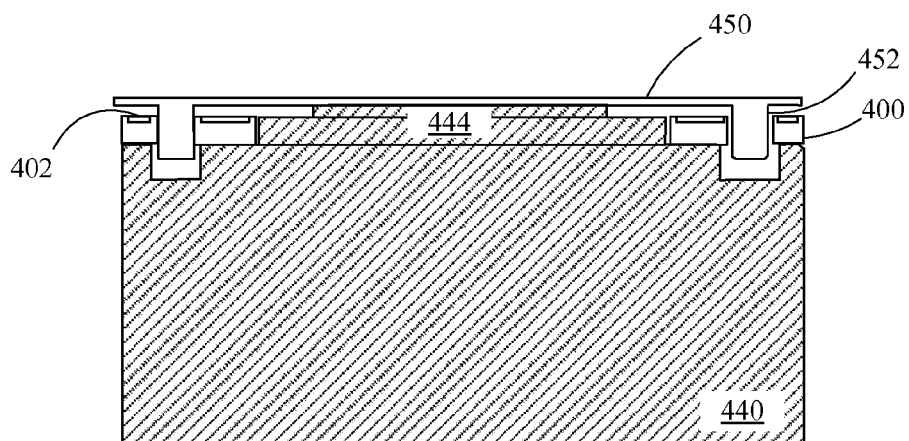


FIG. 4D

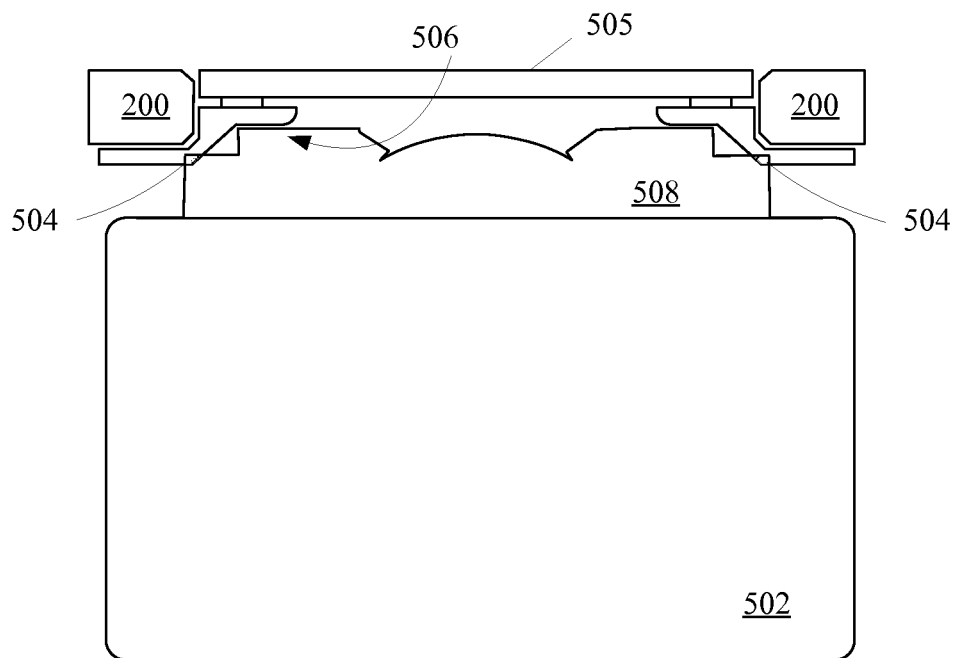


FIG. 5A

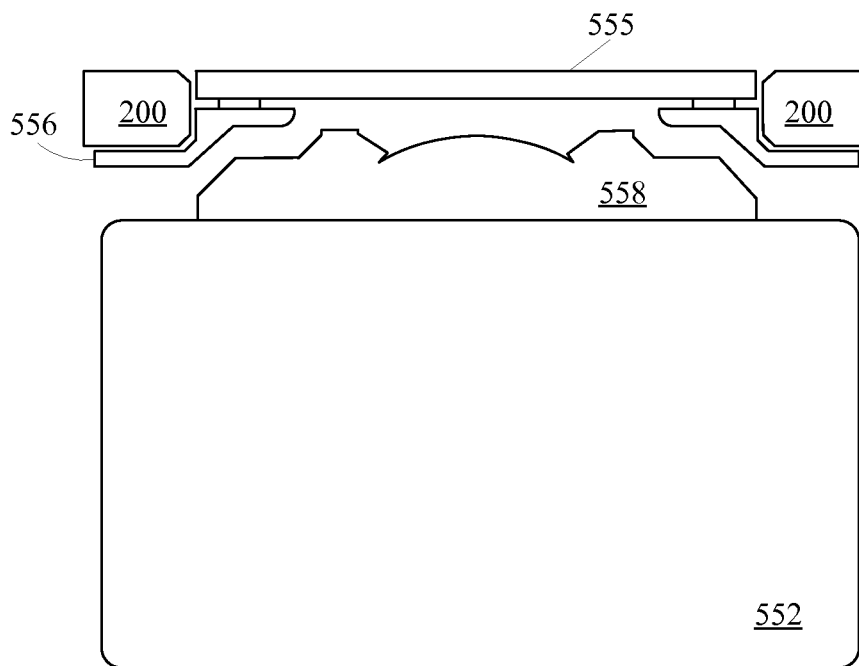


FIG. 5B

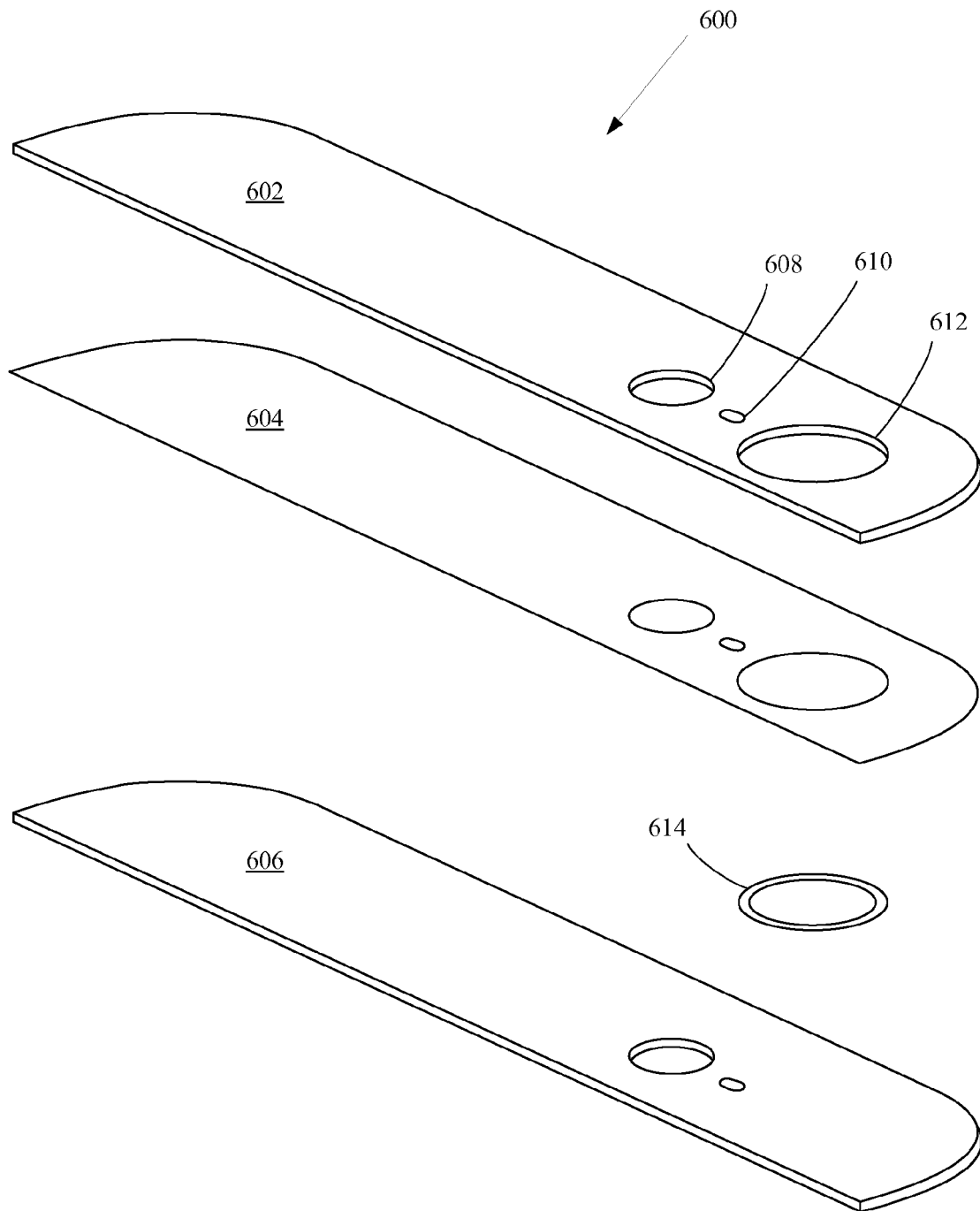


FIG. 6

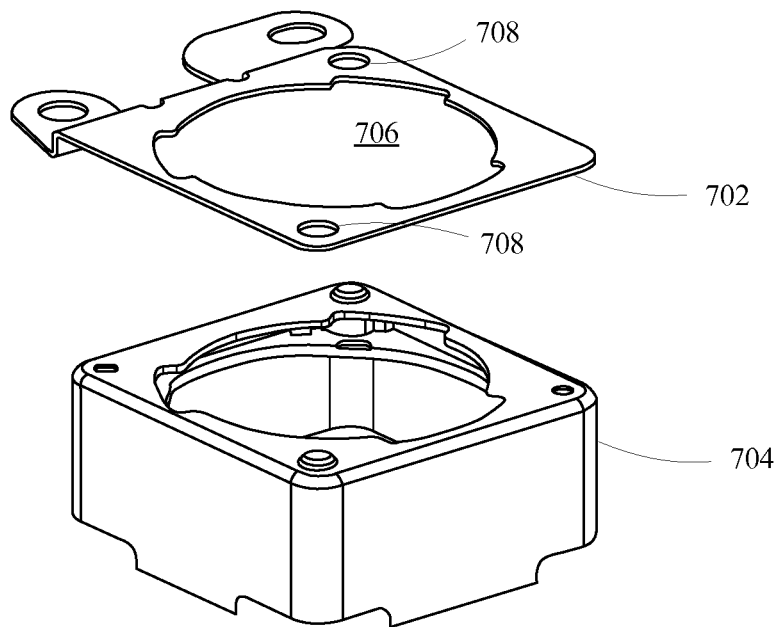


FIG. 7A

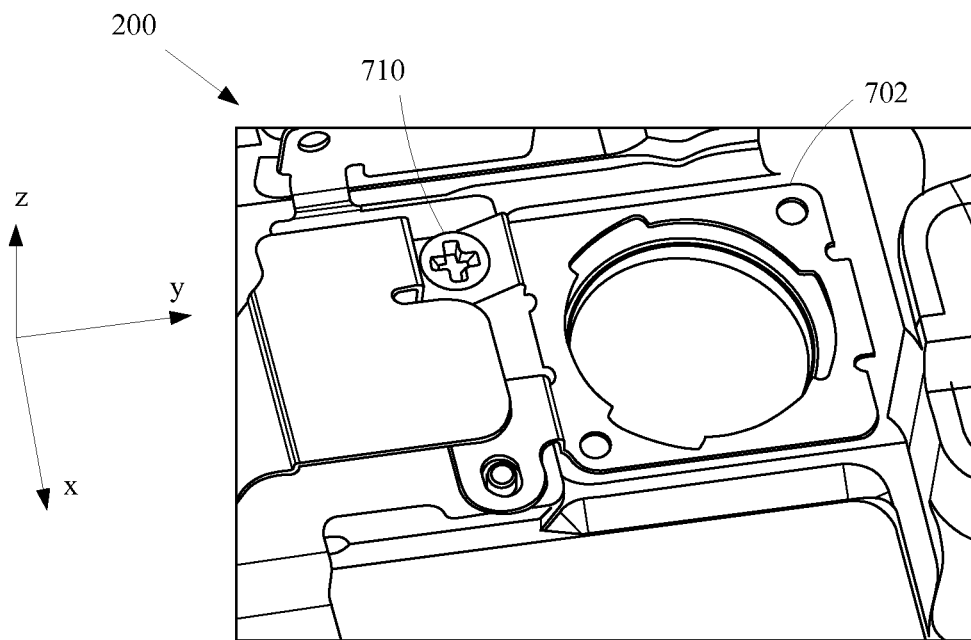
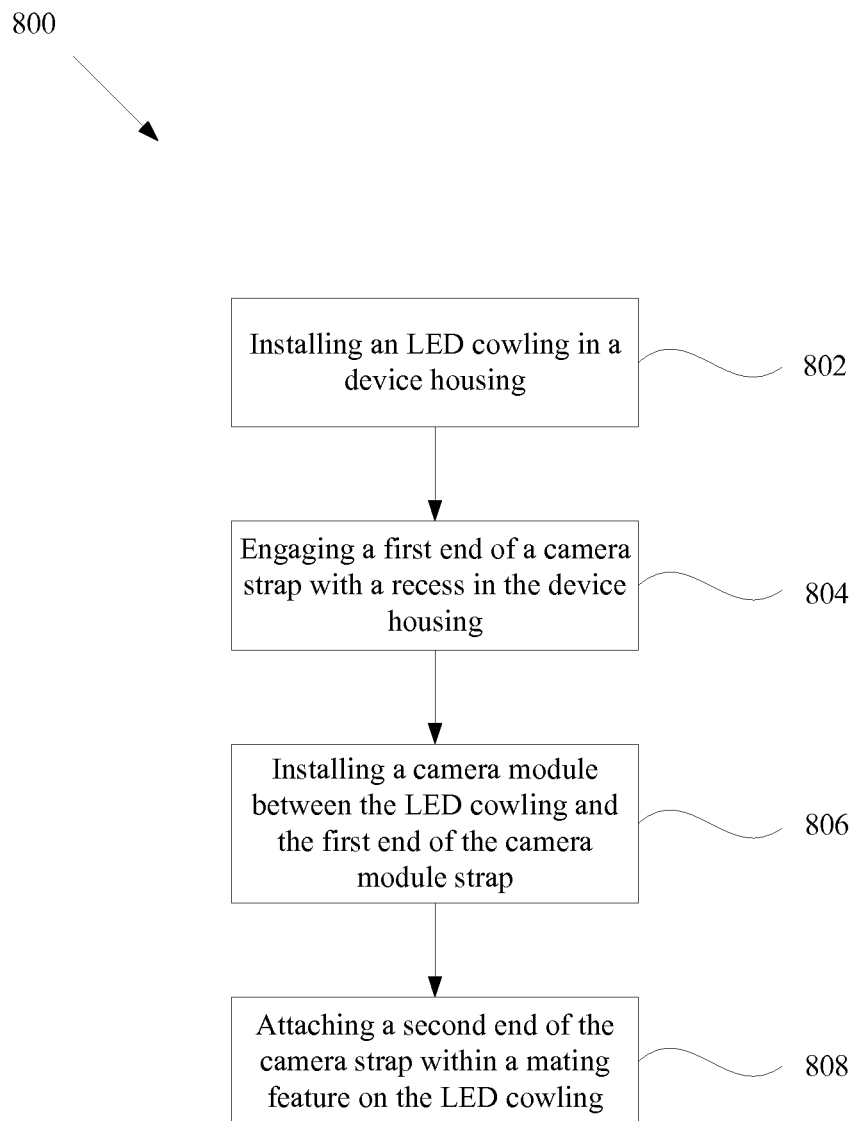


FIG. 7B

*FIG. 8*

1

## CAMERA RELATED FEATURES OF A MOBILE PHONE OR COMPUTING DEVICE

### CROSS-REFERENCE TO RELATED APPLICATION(S)

This application claims the benefit of priority under 35 U.S.C §119(e) to U.S. Provisional Application No. 61/873,745, filed on Sep. 4, 2013, the disclosure of which is incorporated herein by reference in its entirety.

### FIELD

The described embodiments relate generally to methods and apparatuses for mounting a camera module within an electronic device. In particular various grounding and shock mounting apparatuses are described.

### BACKGROUND

As electronic devices continue to include increasingly greater numbers of features, integration of those features into a single device becomes increasingly complex. One particular feature that has become ubiquitous in popular portable electronic devices is imaging operations enabled by camera modules. Because camera modules include fragile elements such as lens elements and electronics, proper mounting of these modules is important to protect them from damage. Furthermore, improper alignment of the camera module within an electronic device can result in unexpected or even degraded imaging performance. Unfortunately, achieving robust shock mounting and reliable camera alignment can be problematic, especially in situations where those shock mounting and alignment features need to fit in highly constrained spaces.

### SUMMARY

This paper describes various embodiments that relate to securing and protecting a camera module within a device housing.

In one aspect, a camera module securing assembly for securing a camera module within a device housing is described. The camera module securing assembly includes a camera retention strap and a cowling. The camera retention strap has a first end and a second end; the first end and the second end are disposed on opposite sides of the camera retention strap. The first end attaches to the device housing. The camera retention strap is designed to secure the camera module within the device housing and limit the camera module from movement. The cowling includes a fastener and a retention arm. The fastener secures the cowling to an internal surface of the device housing. Once the second end of the camera retention strap engages the retention arm, the camera retention strap secures the camera module within the device housing.

In another aspect, a protective assembly providing protection against an external force to a front surface of a camera module in a portable electronic device is described. The protective assembly includes an elastomeric shock mount, an elastomeric camera retention strap, and a metal trim ring. The elastomeric shock mount is coupled to the front surface of the camera module. The elastomeric retention strap extends across a back surface of the camera module. The metal trim ring includes several alignment pins. Each alignment pin passes through one of several openings in the elastomeric shock mount. Each alignment pin engages an opening on the

2

front surface of the camera module. To prevent the camera from breaking and/or misalignment, the elastomeric camera retention strap and elastomeric shock mount dissipate external forces acting on the camera module.

In another aspect, a method for securing a camera module in an electronic device housing is described. A cowling is fastened within the electronic device housing. The cowling has a first retention arm. A camera retention strap is provided; the camera retention strap has a first end and a second end. The first end and the second end are disposed on opposite sides of the camera retention strap. The first end of the camera retention strap is inserted into a recess within the electronic device housing. The camera module is installed in the electronic device housing between the cowling and the first end of the camera retention strap. Once installed, the camera module continuously engaged with a portion of the cowling. Finally, the second end of the camera retention strap engages the first retention arm, and the camera module is secured.

Other aspects and advantages of the invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the described embodiments.

### BRIEF DESCRIPTION OF THE DRAWINGS

The described embodiments may be better understood by reference to the following description and the accompanying drawings. Additionally, advantages of the described embodiments may be better understood by reference to the following description and accompanying drawings in which:

FIG. 1A shows a perspective view of a multi-purpose light emitting diode (LED) cowling;

FIG. 1B shows a perspective view of a camera retention strap;

FIG. 2A shows a perspective view of a top portion of a housing having a multi-purpose LED cowling;

FIG. 2B shows a perspective view of the housing of FIG. 2A further including a camera retention strap having a first end engaged with the housing;

FIG. 2C shows a perspective view of the housing of FIG. 2B further including an installed camera module disposed between the multi-purpose LED cowling and the camera retention strap;

FIG. 2D shows a perspective view of the housing of FIG. 2C further illustrating how a second end of the camera strap can be coupled with the multi-purpose LED cowling;

FIGS. 3A-3B show perspective views of a camera retention strap including a layer of conductive rip-stop;

FIGS. 3C-3D show perspective views of the camera retention strap of FIGS. 3A-3B coupled with a multi-purpose LED cowling;

FIGS. 4A-4B show perspective views of various embodiments configured to provide a shock mounting for a front surface of a camera module;

FIGS. 4C-4D show perspective and cross-sectional views of a camera assembly, the shock mount depicted in FIG. 4A, and a metal trim component;

FIGS. 5A-5B show how a camera can be sculpted to have a size and shape in accordance with other components of a device enclosure;

FIG. 6 shows a low-profile composite patch that can be used to form a window through which a camera module can take images;

FIGS. 7A and 7B show perspective views of an alternative camera grounding and alignment apparatus; and

FIG. 8 shows a block diagram illustrating a method by which a camera module can be installed within an enclosure.

#### DETAILED DESCRIPTION

Representative applications of methods and apparatuses according to the present application are described in this section. These examples are being provided solely to add context and aid in the understanding of the described embodiments. It will thus be apparent to one skilled in the art that the described embodiments may be practiced without some or all of these specific details. In other instances, well known process steps have not been described in detail in order to avoid unnecessarily obscuring the described embodiments. Other applications are possible, such that the following examples should not be taken as limiting.

In the following detailed description, references are made to the accompanying drawings, which form a part of the description and in which are shown, by way of illustration, specific embodiments in accordance with the described embodiments. Although these embodiments are described in sufficient detail to enable one skilled in the art to practice the described embodiments, it is understood that these examples are not limiting; such that other embodiments may be used, and changes may be made without departing from the spirit and scope of the described embodiments.

Camera modules can be secured within a device housing in a number of ways. In some embodiments the camera module is held between opposing interior surfaces of a device housing. Unfortunately, such a configuration can be problematic as prior to closing the device housing the camera module can move or shift out of alignment within the system. One solution to this problem is to include shock-absorbing elements at front and rear portions of the camera module. Unfortunately, shock mounts tend to take away from space available within the device housing, thereby limiting a size of a camera module that can fit within that constrained space. Since larger camera modules generally yield superior imaging results, this can be highly problematic. One solution is to design the shock absorbing elements to within unused space in the device housing. For example, many camera modules include a protruding front lens element. By placing an elastomeric layer around a peripheral portion of the protruding front lens element, the front portion of the camera module can be cushioned without sacrificing space that could be used to enlarge the camera module.

One solution to adding a rear shock mounting to the camera module without adversely affecting available space in the device housing is to add an elastomeric camera retention strap that fits around a rear surface of the camera module. The elastomeric camera retention strap can have a thickness of about 150 microns, and thereby take away minimal space otherwise useful for containing the camera module. In this way, both sides of the camera module can be protected from impact events.

In addition to providing robust shock mounting, the shock mounting system can further be utilized to electrically ground the camera module. In one embodiment, the camera retention strap can include a layer having a matrix of conductive fibers that can form an electrically conductive grounding path between the camera module and an attachment point of the camera retention strap. Alternatively, on installation of camera module within the device housing, the camera module can be put into contact with grounding springs that provide the electrically conductive pathway. In some embodiments the grounding springs can be an element of a multi-purpose light emitting diode (LED) cowling that is also operative to retain

one end of the camera retention strap. Multi-purpose LED cowling can also be operative to provide an electrically conductive grounding path to a main logic board and an antenna component.

In another embodiment, space within the device housing can be more fully utilized by sculpting a portion of the camera module. For example, a protruding portion of a camera module often is cylindrical in nature; however, portions of the cylindrical housing are frequently made of a solid material that contains no functional components. When these solid portions reduce clearance space between the camera module and a portion of the device housing, the solid portions can be removed, leaving an outer surface that more precisely matches features of the device housing. In this way, a camera module that would not normally fit in a given space can be utilized. In yet another embodiment, space within the device housing can be created by removing a trim ring commonly associated with the camera module. Instead of using a traditional trim ring that supports a camera lens cover, a composite patch can be utilized that overlays a substantial portion of a back surface of the device housing. In this way an amount of space can be saved that would otherwise be occupied by the trim ring.

These and other embodiments are discussed below with reference to FIGS. 1-8; however, those skilled in the art will readily appreciate that the detailed description given herein with respect to these figures is for explanatory purposes only and should not be construed as limiting.

FIG. 1A shows a perspective view of a multi-purpose light emitting diode (LED) cowling 100 primarily configured to secure an LED (not depicted) and a microphone module (not depicted) within an electronic device housing. Multi-purpose LED cowling 100 includes two structural members 102 and 104 that can be welded together at weld points 106. In some embodiments structural members 102 and 104 can be formed from stainless steel. Fiducials 108 can assist in alignment of structural members 102 and 104 prior to welding the two members together at weld points 106. Structural member 102 as depicted includes retention arms 110 designed to secure one end of a camera retention strap (see FIG. 1B). Structural member 102 can also include grounding springs 112. Grounding springs 112 can be operative to contact a portion of the camera module such that multi-purpose LED cowling 100 can be operative as a grounding pathway for the camera module. An electrically conductive pathway can begin at grounding springs 112, run through structural member 102, pass into structural member 104 and finally continue to chassis ground through a fastener (not depicted) that secures multi-purpose LED cowling 100 to an internal surface of the electronic device housing through fastener opening 114. In this way, a camera module (shown later) grounded through grounding springs 112 can be electrically isolated from a proximate antenna component. The proximate antenna component can also be grounded through multi-purpose LED cowling 100 by way of fastener opening 115.

Structural member 102 can also include main logic board (MLB) grounding spring 116. MLB grounding spring 116 can be configured to deform and be electrically coupled to edge plating on an MLB of the electronic device once the MLB is installed. In this way multi-purpose LED cowling 100 can be operative as a ground for the camera module, an antenna component and the MLB. Structural member 102 can further include light shielding reflectors 118. Light shielding reflectors 118 can be operative to prevent light from an LED disposed within multi-purpose LED cowling 100 from escaping into the device. In this way, additional light that would

5

otherwise be wasted can be redirected out an opening associated with the LED thereby increasing light output and efficiency of the LED.

Multi-purpose LED cowling **100** may further include rib **117**. As shown in FIG. 1A, rib **117** engages structural member **102** and vertical member **119** to ensure a perpendicular relationship between structural member and vertical member **119**.

FIG. 1B shows camera retention strap **120**. In some embodiments, camera retention strap **120** can be made from an elastomeric material. The elastomeric material can provide cushioning that can help protect a rear portion of a camera module to which it is secured in the event an electronic device within which the camera module is disposed is dropped. Camera retention strap **120** includes retention features **122** and **124** that have geometry allowing them to be coupled to various mating features included in an electronic device. In particular, retention feature **122** is configured to mate with retention arms **110** of multi-purpose LED cowling **100**, while retention feature **124** can have a dovetailed geometry configured to match a mating feature disposed within the electronic device housing. In some embodiments, retention features **122** and **124** do not need to be adhesively coupled to secure a camera module, thereby simplifying removal of camera retention strap **120**. Camera retention strap **120** can further include central region **126** having a shape and size in accordance with a back surface of a camera module. In this way, any retaining force applied by camera retention strap **120** can be evenly spread across the back surface of the camera module. In some embodiments, central region **126** can be contoured to avoid putting pressure on particularly sensitive or fragile regions of the camera module. Still, in still other embodiments, an opening can be placed in central region **126** to relieve pressure on a targeted area. In yet other embodiments, central region **126** can include a grid region or waffle pattern to reduce an amount of material of camera retention strap **120**. In one specific embodiment, central region **126** of camera retention strap **120** can have a thickness of about 150 microns.

FIGS. 2A-2D show a number of views representative of a process for installing camera retention strap **120** around a camera module. FIG. 2A shows a perspective view of an interior portion of an electronic device housing **200**. As depicted, multi-purpose LED cowling **100** can be preinstalled within housing **200**. Multi-purpose LED cowling **100** can be attached to housing **200** at fastener openings **114** and **115**. Although not depicted, an LED module can be disposed within multi-purpose LED cowling **100** such that it can emit light through opening **206**. Housing **200** can also include a mating feature **208** configured to retain a retaining feature of camera retention strap **120**.

FIG. 2B shows camera retention strap **120** partially coupled with housing **200**. Retention feature **122** is shown inserted within mating feature **208**. The dovetailed geometry of retention feature **122** can allow retention feature **122** to be captured within mating feature **208**. FIG. 2C shows camera module **210** installed within housing **200**. In this position, retention feature **122** of camera retention strap **120** can be secured between mating feature **208** and camera module **210**. As camera module **210** is inserted within housing **200**, camera module **210** is also electrically grounded to housing **200** by grounding springs **112** of multi-purpose LED cowling **100**. Grounding springs **112** can be slightly deformed as camera module **210** exerts pressure against them, so that grounding springs **112** are firmly pressed against camera module **210**. FIG. 2D shows a final assembly step in which retention feature **124** of camera retention strap **120** secured to

6

retention arms **110** of multi-purpose LED cowling **100**. In this way, central portion **126** of camera retention strap **120** can evenly distribute a force against a back surface of camera module **210**. An amount of force exerted upon camera module **210** can be directly related to a length of camera retention strap **120**. In this way, a precise amount of force can be applied to camera module **210** by properly sizing a length dimension of camera retention strap **120**. It should also be noted that a thickness of central portion **126** of camera retention strap **120** can be varied to provide a degree of shock mounting for camera module **210**. In some embodiments, central portion **126** can be pushed directly against another structural element such as a layer of cover glass.

FIG. 3A shows an alternative camera retention strap embodiment. In this embodiment a layer of rip-stop material can be coupled to camera retention strap **120**. In one particular embodiment, the rip-stop material can be laminated to camera retention strap **120**. FIG. 3A shows rip-stop layer **302** positioned above camera retention strap **120**, while FIG. 3B shows rip-stop layer **302** subsequent to lamination of rip-stop layer **302** against camera retention strap **120**. In another embodiment, rip-stop layer **302** can also be adhesively coupled to camera retention strap **120** by a layer of adhesive affixed to a bottom surface of rip-stop layer **302**. Rip-stop layer **302** can prevent tears from forming and propagating along an elastomeric camera retention strap **120**. Rip-stop layer **302** includes a number of fibers **304** (see grid depicted in FIGS. 3A and 3B) that can further halt progression of rips in elastomeric camera retention strap **120**. In certain cases, rip-stop layer **302** can prevent ripping of camera retention strap **120** during installation. In some embodiments, fibers **304** embedded within rip-stop layer **302** can be conductive fibers **304**. Conductive fibers **304** can be used to conduct current to ground across a surface of rip-stop layer **302**. It should be noted that because rip-stop layer **302** is substantially rigid it can prevent uneven stretching of camera retention strap **120**. In this way, camera retention strap **120** can have a consistent thickness that allows it to provide protection for a camera module in vulnerable areas of the camera module. It should also be noted that by shaping rip-stop layer **302** in particular portions, camera retention strap **120** overlaid by rip-stop layer **302** can be prevented from stretching. While a substantially conformal rip-stop layer **302** is depicted in FIGS. 3A-3B this shape could be adjusted when testing indicates certain areas need more or less strengthening or support.

FIG. 3C shows a perspective view of camera retention strap **120** coupled with a multi-purpose LED cowling **320**. It should be noted that multi-purpose LED cowling **320** is slightly different than multi-purpose LED cowling **100** (shown in FIG. 1A) in that it does not include grounding springs **112**. Instead of using grounding springs, multi-purpose LED cowling **320** utilizes conductive rip-stop layer **302** to electrically couple camera module **306** (see FIG. 3D) with multi-purpose LED cowling **320**. When camera retention strap **120** is in direct contact with camera module **306**, conductive fibers **304** can provide an electrically conductive grounding path to mating feature **322** of multi-purpose LED cowling **320**. Such a configuration can be advantageous as a configuration without grounding springs is simpler to manufacture and there is no risk of grounding springs being bent or deformed during a drop event. Furthermore, as discussed above, rip-stop layer **302** provides a more robust camera retention strap **120** that is less likely to tear and/or fail during use.

FIGS. 4A-4B shows various embodiments of a shock mount for a front surface of a camera module. FIG. 4A shows that shock mount **400** is a primarily elastomeric part having a

metal plate **402** disposed across a top surface of the part. Metal plate **402** is integrated along a top surface such that metal plate **402** provides reinforcement for alignment pin openings **404** and **406**. Metal plate **402** is also operable to provide reinforcement for opening **408** through which a front protruding lens portion of a camera module is configured to pass. Elastomeric layer **410** is arranged around openings **404** and **406** and provides an amount of shock protection in case of shearing stresses. This shearing protection can prevent alignment pins (not depicted) from breaking off during a drop event. In the case of opening **408**, the shearing protection can reduce an amount of shock transmitted to front lens elements of an associated camera module. A distance between metal plate **402** and the various openings in shock mount **400** can be adjusted to provide additional cushioning by enlarging the distance, or provide improved alignment by reducing the distance. Furthermore, a thickness of elastomeric layer **410** can dissipate shocks applied along a plane normal to a top surface of the shock mounting. In this way, shock mount **400** can provide shock mounting in all three axes.

FIG. **4B** shows an alternative embodiment of shock mount **420** for the front surface of a camera module. Shock mount **420** includes rigid top plate **422**, rigid bottom plate **424**, and elastomeric layer **426** sandwiched between rigid top plate **422** and rigid bottom plate **424**. In this way, shock mount **420** can provide reduced shock to an axis normal to a top surface of shock mount **420**. Shock mount **420** can be welded to a top surface of a camera module. Openings **428** provide access to bottom plate **424** through elastomeric layer **426**, thereby allowing a welding operation to weld bottom plate **424** to a top surface of a camera module, while openings **430** pass entirely through shock mount **420**. Openings **430** can serve multiple purposes. For example, openings **430** can act as fiducials for aligning shock mount **420** with a camera module prior to a welding operation. Additionally, openings **430** can allow alignment pins to pass through shock mount **420**. Shock mount **420** can also provide precise alignment of alignment pins with a camera module since the alignment pins can be in direct contact with rigid top plate **422**.

FIG. **4C** shows how shock mount **400** of FIG. **4A** can be assembled with camera module **440** having a top protruding portion **444** and metal trim component **450** having an opening **454**. Metal trim component **450** includes metal alignment pins **452** configured to pass through shock mount **400** and extend at least partially into openings **442** of camera module **440**. When shock mount **400** is securely coupled with camera module **440**, metal alignment pins **452** do not have to extend substantially into openings **442** and in the event of substantial compression, alignment pins **452** can be driven into openings **442** without impacting camera module **440**. Furthermore, in some embodiments, alignment pins **452** shorter pins may have a length of approximately 0.7 mm. Such a length may lead to a lower likelihood of shearing off during a drop event.

Assembly of the parts can be accomplished by a pick and place, which can result in high precision alignment of each of the parts. High precision alignment of the parts can reduce an amount of tolerance between the parts, thereby reducing an amount of clearance for required for the parts. Furthermore, tight tolerances of the various parts decrease sample variation and can reduce alignment errors in the camera module. Shock mount **400** can be adhesively coupled or welded to a top surface of camera module **440**. FIG. **4D** shows a cross-sectional side view in which shock mount **400** is assembled together with camera module **440** and metal trim component **450**. This view illustrates how elastomeric portions of shock mount **400** can be utilized to reduce shearing forces on alignment pins **452** and a top protruding portion **444** of camera

module **440**. It should be noted that in some embodiments, the opening for the trim component **450** does not come into contact with top protruding portion **444** of camera module **440**. It should also be noted that metal trim component **450** can be secured proximate to an opening in a device housing, so that it can provide support for a lens cover configured to allow light to enter the device housing and camera module **440**.

FIGS. **5A-5B** show a method of sculpting a protruding lens portion of a camera module to create increased vertical space for a camera module. Camera module manufacturers often create a cylindrical protruding lens region **508** larger than needed given positioning of interior elements within camera module **502**. For example, FIG. **5A** shows how using a relatively taller camera module in place of a shorter camera module can be problematic. Here, camera trim **505** includes an engaging portion **506** configured to engage a (relatively taller) protruding lens region **508** of camera module **502**. The region denoted as **504** is an overlapping region. In order to maintain the existing spatial relationship between camera trim **505** and camera module **502**, engaging portion **506** would need to overlap portions of protruding lens region **508** in the overlapping region **504**. Because these structures—engaging region **506** and protruding lens region **508**—cannot overlap, it is clear that protruding lens region **508** is too tall to fit in this constrained space, and there may be insufficient room for enclosure housing.

However, when a protruding lens region of a camera module is made of plastic or some other malleable material, it can be sculpted, or shaped, to have a similar profile as that of engaging portion of the camera trim, thereby allowing a camera module to conform to restricted dimensions associated with an electronic device. FIG. **5B** shows protruding lens region **558** being reshaped to create additional space within enclosure housing **200** to eliminate an overlapping region. In this way camera module **552** can have sufficient standoff from camera trim **555** trim ring **556** so that in the event of a drop event, camera module **552** can shift slightly forward without striking camera trim **555**. Further, the restricted dimensions of enclosure housing **200** can accommodate camera module **552** with a relatively taller protruding lens region **558**.

FIG. **6** shows a composite antenna patch **600** that eliminates a distinct trim ring as depicted in FIGS. **5A** and **5B**. Composite antenna patch **600** can be radio frequency (RF) neutral so that wireless data can pass into and out of a device through composite antenna patch **600**. Radio frequency neutral material can include, for example, plastic and glass material. Composite antenna patch **600** can include a number of layers including interior patch **602**, adhesive layer **604** and outer patch **606**. Adhesive layer **604** can be used to bind inner patch **602** to outer patch **606**. In one particular embodiment, inner patch **602** can be approximately 0.3 mm thick and outer patch **606** can be approximately 0.5 mm thick. In other embodiments, each layer can include both LED opening **608** and microphone opening **610**. LED opening **608** can be useful for aligning an LED with a portion of composite antenna patch **600**. In some embodiments, an LED can be disposed entirely through each of layers **602**, **604**, and **606** interior patch **602**, adhesive layer **604**, and outer patch **606** so that a light-emitting surface of the LED is flush with an outer surface of outer patch **606**. In other embodiments, the LED can be recessed back from the outer surface of outer patch **606**. Inner patch **602** can also include camera opening **612**. Camera opening **612** can be utilized to provide alignment between a camera module and inner patch **602**. Instead of utilizing a trim ring to support a lens cover, a solid outer patch **606** can be disposed across camera opening **612**. In some embodi-

ments, outer patch 606 can be a glass layer so as not to adversely impact light passing through outer patch 606 and into an underlying camera module. Because a trim ring can take up more than 0.5 mm of space within an enclosure, the omission of a trim ring can increase clearance within an enclosure, thereby allowing for larger camera modules having improved image quality over smaller modules. It should be noted that in some embodiments a separate cosmetic trim ring 614 can be aligned with adhesive layer 604 to provide an outward appearance of a more traditional trim ring. Because cosmetic trim ring 614 is primarily cosmetic in purpose, it can have a thickness that does not exceed a thickness of the adhesive layer.

FIG. 7A shows an alternative camera grounding and alignment bracket. Top cover 704 (for a camera module) can provide a substrate upon which an alignment bracket 702 can be mounted. Alignment bracket 702 can include an opening 706 through which top cover 704 can receive light. Furthermore, alignment bracket 702 can include threaded openings 708, or in some cases just smooth openings 708, for aligning and/or securing top cover 704 to alignment bracket 702. Top cover 704 can be secured to alignment bracket 702 in many ways including, for example, by an adhesive or by welding the two components together. Because alignment bracket 702 is formed from a metal material, it provides rigid X-Y alignment for top cover 704. Alignment bracket 702 can be mechanically coupled directly to housing 200 by at least fastener 710, as depicted in FIG. 7B. In this way, when top cover 704 engages bracket 702, the camera module is properly aligned with housing 200 and grounded to chassis ground through alignment bracket 702.

FIG. 8 shows a block diagram illustrating a method 800 by which a camera module can be installed within an enclosure. In a first step 802, a multi-purpose LED cowling is installed within a device housing. At step 804, a first end of a camera retention strap is engaged with a recess in the device housing proximate to the installed multi-purpose LED. At step 806, a camera module is placed between the multi-purpose LED cowling and the first end of the camera retention strap. By placing the camera module in this position a first side of the camera module is electrically coupled to grounding pins extending from the multi-purpose LED cowling, while a second side of the camera module opposite the first side pushes against a retention feature of the first end of the camera retention strap such that the first end is secured within the recess in the device housing. At step 808, the camera retention strap is stretched across a back surface of the camera module, and a second end of the camera retention strap is engaged with a mating feature of the multi-purpose LED cowling.

The various aspects, embodiments, implementations or features of the described embodiments can be used separately or in any combination. Various aspects of the described embodiments can be implemented by software, hardware or a combination of hardware and software. The described embodiments can also be embodied as computer readable code on a computer readable medium for controlling manufacturing operations or as computer readable code on a computer readable medium for controlling a manufacturing line. The computer readable medium is any data storage device that can store data which can thereafter be read by a computer system. Examples of the computer readable medium include read-only memory, random-access memory, CD-ROMs, HDDs, DVDs, magnetic tape, and optical data storage devices. The computer readable medium can also be distributed over network-coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

The foregoing description, for purposes of explanation, used specific nomenclature to provide a thorough understanding of the described embodiments. However, it will be apparent to one skilled in the art that the specific details are not required in order to practice the described embodiments. Thus, the foregoing descriptions of specific embodiments are presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the described embodiments to the precise forms disclosed. It will be apparent to one of ordinary skill in the art that many modifications and variations are possible in view of the above teachings.

The invention claimed is:

1. A camera module securing assembly for securing a camera module within a device housing, the camera module securing assembly comprising:

a camera retention strap having a first end and a second end, the second end opposite the first end that attaches to the device housing;

wherein the camera retention strap limits movement of the camera module and provides a cushioning against an external force; and

a cowling comprising:

a fastener that secures the cowling to an internal surface of the device housing; and

a retention arm that receives the second end of the camera retention strap and secures the camera module.

2. The camera module securing assembly as recited in claim 1, further comprising:

a shock mount configured to be coupled with a front surface of the camera module, the shock mount having a first aperture and a second aperture.

3. The camera module securing assembly as recited in claim 2, wherein the camera retention strap and the shock mount are made of an elastomeric material, and wherein the fastener of the cowling electrically grounds the cowling.

4. The camera module securing assembly as recited in claim 2, the shock mount further comprising a metal plate on a top surface of the shock mount, wherein the metal plate provides reinforcement to the first aperture and the second aperture.

5. The camera module securing assembly as recited in claim 4, wherein the cowling is a multi-purpose light emitting diode (LED) cowling.

6. The camera module securing assembly as recited in claim 4, further comprising:

a metal trim component positioned over the shock mount, the metal trim component having a first pin and a second pin; and

wherein the first pin engages the first aperture of the shock mount and the second pin engages the second aperture of the shock mount.

7. The camera module securing assembly as recited in claim 6, wherein the first pin of the metal trim component engages a first cavity of the camera module, and wherein the second pin of the metal trim component engages a second cavity of the camera module.

8. The camera module securing assembly as recited in claim 1, the camera retention strap further comprising a rip-stop coupled to a central portion of the camera retention strap.

9. The camera module securing assembly as recited in claim 8, wherein the rip-stop further comprises a conductive layer having conductive fibers, the conductive fibers operable to provide an electrically conductive grounding path.

10. The camera module securing assembly as recited in claim 1, further comprising a grounding spring, wherein the

## 11

grounding spring engages the camera module, and wherein the grounding springs provides an electrical ground for camera module.

11. The camera module securing assembly as recited in claim 1, wherein the camera retention strap exerts a retaining force on a back surface of the camera module.

12. The camera module securing assembly as recited in claim 1, the cowling comprising a light shield reflector, the light shield reflector operable to prevent light from escaping the cowling.

13. A protective assembly providing protection against external forces to a front surface of a camera module in a portable electronic device, comprising:

an elastomeric shock mount mechanically coupled to the front surface of the camera module, the front surface including a lens portion;

an elastomeric camera retention strap extending along a back surface of the camera module;

a metal trim ring having a plurality of alignment pins configured to pass through a plurality of openings in the elastomeric shock mount and into openings disposed along the front surface of the camera module; and

wherein the elastomeric camera retention strap and elastomeric shock mount cooperate to dissipate the external forces applied to the camera module.

14. The protective assembly of claim 13, wherein the metal trim ring includes an angled surface, the angled surface of the metal trim ring corresponding to an angled surface of a protruding lens portion positioned between the camera module and the metal trim ring.

## 12

15. The protective assembly of claim 14, wherein the elastomeric shock mount provides protection from a drop event in a first dimension, a second dimension, and a third dimension.

16. The protective assembly of claim 13, wherein the elastomeric shock mount includes a metal plate disposed on a top surface of the elastomeric shock mount, the metal plate configured to provide reinforcement to an opening of the elastomeric shock mount.

17. A method for securing a camera module in an electronic device housing, comprising:

fastening a cowling within the electronic device housing, the cowling having a first retention arm;

providing a camera retention strap having a first end and a second end;

inserting the first end of the camera retention strap into a recess within the electronic device housing;

installing the camera module in the electronic device housing between the cowling and the first end of the camera retention strap, the camera module continuously engaging a portion of the cowling; and

engaging the second end of the camera retention strap with the first retention arm.

18. The method as recited in claim 17, wherein the camera module is electrically coupled to grounding springs of the cowling.

19. The method as recited in claim 17, wherein the camera retention strap includes a conductive layer rip-stop for electrically grounding the cowling.

20. The method as recited in claim 17, wherein the camera retention strap is made of an elastomeric material.

\* \* \* \* \*